2011 2nd International Conference on Environmental Science and Development
IPCBEE vol.4 (2011) © (2011) IACSIT Press, Singapore

Land Evaluation for Extensive Recreation Using Spatial Multi Criteria Evaluation Method

Seyed Ali Jozi
Department of Environment, Islamic Azad University, North Tehran Branch, Tehran, Iran
e-mail: sajozi@yahoo.com

Narges Zaredar
Graduate students of Environmental Science, Islamic Azad University, Science and Research Branch, Tehran, Iran
e-mail: narges_zaredar@yahoo.com

Sahar Rezaian
Department of Environment, Islamic Azad University, Shahrood Branch, Shahrood, Iran
e-mail: s_rezaian@yahoo.com

***Abstract*—Growing use of natural resources reveals the importance of land capability evaluation studies. But caring out such studies involve considering a lot of criteria in different aspects like environmental and socio economic factors. Meanwhile traditional studies have many deficiencies including being expensive and time consuming as well as lack of a proper handle of various qualitative and quantitative criteria. This study aims to investigate the land evaluation of Varjin, a protected area near the Tehran, for implementation of extensive recreations using spatial analytical hierarchy process. Existence of many natural attractive sceneries as well as proximity to the capital city of Tehran caused this region to be a suitable area for recreational purposes. Totally, 16 layers information are utilized as criterion maps for evaluation of extensive recreational potential usage. Results showed that, totally 63.17% of 26907 ha from the area for implementation of extensive recreation were recognized as suitable. Also result of this study showed the effectiveness of spatial analytical hierarchy process in land analysis issues.**

Keywords: Extensive Recreation; Fuzzy logic; Multi criteria decision-making; Extensive recreation; Pair wise comparison; Dimensionless;

I. INTRODUCTION

Nowadays human being deals with a new problem, how it is possible to use of land in a sustainable manner. There are broad ranges of deterioration such as soil erosion, land use changes and flood has been occurred due to misuse of land. Finding a suitable method of land use aimed to meet human needs while preserving the environment so that these needs can be met not only in the present, but also for future generations [3].Evaluation of ecological capability carried out using various methods is a basic study to achieve sustainable development goals. Since these kinds of studies involves many qualitative and quantitative criteria and also differentiation of stakeholders, which makes decision making process difficult, choosing of suitable method for handling such a broad data is an very important [7]. In the study ahead, ecological capability of Varjin protected area for developing extensive recreation has been evaluated based on AHP method using Geographical Information System in 2008.The AHP was developed by Saaty in the 1970s [14,13] as a suitable tools to multi-objective decision making. Nowadays AHP is broadly used by different scientist. Carried out research in case of railway station site selection using AHP[6]. Four main criteria including rail-related, passenger services, architecture and urbanism, and economics as well as 26 sub-criteria were selected. The approach of this study was alternative focused and five (potential) candidates or alternatives were determined. They finally proposed data envelopment analysis (DEA) model to determine the optimum site for a railway station. The result showed that the local priorities derived from the AHP can be considered as the multiple outputs of a DEA model. Performed a GIS-based landslide susceptibility mapping using the analytical hierarchy process (AHP)[2], the statistical index (Wi), and weighting factor (Wf) methods. The results indicated that the AHP method gave a more realistic picture of the actual distribution of landslide susceptibility rather than the other two methods. There are some examples about application of AHP techniques in natural resources: Pest plant prioritisation process in weed management [5]; Land use potential of arable and garden farming [11]; peri-urban agriculture; Elaborating Agricultural Logistics Trends [10].

II. MATERIALS AND METHODS

Varjin Protected area (VPA) one of the unique landscapes of the Alborz mountain range latitudes 35°49' and 36°01'N, and longitudes 51°41'E that covers 26,907 ha. This region has very nice scenery included various rivers, farms and gardens as well as diverse fauna and flora which consists of 577 plant species of 82 families have been identified, of which, 387 species are permanent, 32 being endemic to Iran, and 45 species are domesticated [1]. Location of VPA in Iran is illustrated in Fig. 1.

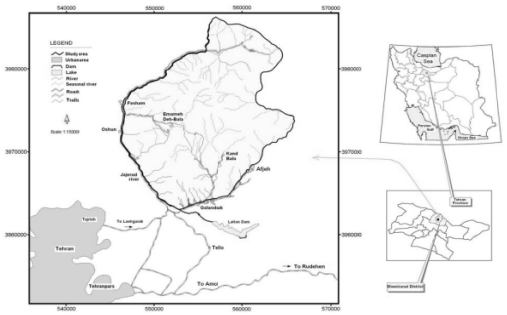

Fig. 1: Location of VPA in Iran [1].

In this research, all the maps were prepared in a 1:100000 scale using MSCD to access the mentioned map. The organization of JAHAD agriculture ministry and Environment of Iran are applied for Spatial Decision Support System (SDSS). The proceeding steps are performed as follows: Firstly, sustainable and unsustainable resources were identified in a research scale. In addition to the preparation of ecologic maps, the distance with main roads and population centres were also provided. Then, the classified elevation slops and aspect maps were prepared using digital elevation model applied in slop maps. Also, the criteria and variables were identified for evaluation of Varjin Protected area. After data collection, standardization of maps was performed in the next step. In other words, the values in the various input maps which have different meanings and expressed in different units of measurement. So in order to compare criteria with each other, all values need to be standardized, i.e. transformed to the same unit of measurement[7]. In this study for standardization of the scale in map layer the fuzzy logic were used. After standardization of map layers, was assigned to each criterion the relative importance, using 9 point judgement scale (Table 1).The calculated weighs is illustrated in Table 2.

TABLE1:JUDGMENT SCALE FOR PAIR-WISE COMPARISONS[12]

Descriptions	Scale
Equally preferred	1
Equally to moderately	2
Moderately preferred	3
Moderately to strongly	4
Strongly preferred	5
Strongly to very Strongly	6
Very Strongly preferred	7
Very Strongly to extremely	8
Extremely preferred	9

TABLE 2. CRITERIA AND WEIGHT OF THEM IN DETERMINATION OF EXTENSIVE RECREATIONAL APPLICATION OF VARJIN PROTECTED AREA

variables	weight
climate	0.0154
Altitude	0.0115
slope	0.2231
Geographical orient	0.0376
Type and concentration of vegetables	0.0925
Diversity of animals	0.0406
Area for animal life breed	0.0611
Ecosystem's diversity of region	0.0624
Area for dispersion of any type of important vegetables	0.0662
Places of any kind of wild life against threaten	0.1213
Main rivers and region runoff	0.0405
Groundwater level	0.0212
Type of Soil	0.0114
Soil texture	0.0128
Distance from habitancy	0.1420
Distance from road	0.0264

2.1. Weighted Linear Combination (WLC)

Weighted Linear Combination (WLC) technique was applied to select the best option (site), according to criteria evaluation method. The site which obtained the highest score is identified as the suitable site or class. In this method, the value of each criterion is calculated by the following equation: $A_i = \sum_j W_j X_{ij}$

Where, Xij is the value of i^{th} alternative towards j^{th} criterion, is a standardized weight as aggregation of all weights is equal to one $\left(\sum W_j = 1\right)$. The calculated weights showed the relative importance of each criterion and preferred alternative is selected by defining of maximum value of A_i (i =1, 2 , 3, … ,n).

In this research, each criterion or sub criterion was weighing using pair wise comparison method and to selecting the preferred criteria, the preference's value table of the Saaty is used. The weight of criteria is determined somehow that these equations have been true:

a11 w1 + a12 w2 + … + a1n wn = λ.w1

a21 w1 + a22 w2 + … + a2n wn = λ.w2

an1 w1 + an2 w2 + … + ann wn = λ.wn

In equation below, a_{ij} is the preference of i^{th} on j^{th}, w_i is the weight of i^{th} element and λ is a constant number. According to above definition, the weight of i^{th} element is equal to:

Wi = 1/λn Σ aij wj , i= 1, 2,…, n , j=1

To ease the calculating of the weights in purpose of preference degrees and hierarchies the Expert choice software was used. To applying the weighted linear combination (WLC) method, the following steps were performed:

- ✓ Determining of evaluation criteria collection (in form of map layers) and total score of each option
- ✓ Standardizing and converting of scale of values (evaluation criteria),
- ✓ Determining the weight of criteria i.e. weight and relative importance of each criterion and layer information
- ✓ Generation of weighting standardizing map layer
- ✓ Generation of final map usages and determining of total score overlaying maps and union function on standardized weighing map layers.

2.3. Providing landform units map

The landform includes natural land units that each one was transformed at the same situation of climate, erosion, weathering and earth summit and was converted to the existing form. The landform unit should be used to identify ecological resources and capability evaluation and also predict soil formation and flora of the region. On the other hand, it introduces the area's physical capability or ecosystem. The main factors to prepare landform units map of each area are slop, aspect and elevation maps that were overlaid under Arc GIS program and each unit's area were calculated (Fig. 4). In this study using the raster calculator order totally 18561 frequent landform unit and 246 units without frequency were identified. For further use of every landform unit's information to planning of flora and wildlife habitats recovery and bonification, it was overlaid with soil map (land units), isothermal lines, isohyetal lines; flora (to determining every type's canopy) and hydrological map (to determining every hydrologic unit's runoff). Then, relevant information of each layer was saved to the geographic information database. In this table, isohyetal line and soil depth by reason of existing probability in several land units were averagely calculated and result was inserted to related column.

2.4. The conceptual model of Varjin protected area's extensive recreational use

To implement of extensive recreational use, the area's that have resistance against walking, establishment of picnicking and child's playing field are suitable. These areas would be 100 meter far from rivers and also have at least 250 meter distance from the high diverse wild life centres and breading areas. The areas with high ecosystem diversity to implementation of this use are taken into account as suitable one which could be extracted by overlay it with landform unit maps. On the other hand the distance of this site from high value vegetative diversity areas would be 500 meters. Proximity to available roads and settlement areas is an advantage for these areas on the condition of respecting 200 meters buffer than region's farmlands and gardens. Suitable areas for implementation of extensive recreation in Varjin Protected area is illustrated in Fig. 2.

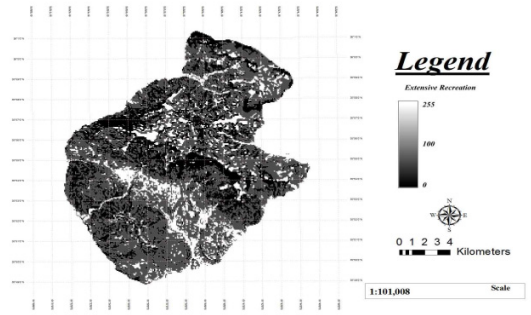

Fig. 2. The map of Varjin's extensive recreation

III. RESULTS AND DISCUSSION

After the allocating these two uses, to definite the planning units, the multi objective land allocation method (MOLA) was used. The base of this method is according to selection of the cells which have the most score for each uses, as well as the least area. For this purpose, in regard to the parameters such as area of region, integrity and allocation, a simultaneous and multiple comparing were performed throughout the area. This stage was applied after weighing criteria as secondary weighing that have significant impact to the final result. In this research the area of each planning unit were determined in regard to the strategy of planning or aims of the study, the scale of research, ecological condition of under investigation arena, the area of the high score cells of each uses, predicting the future variability of environment and also the protection level of arena. After performing the MOLA technique which was done within 19 times alternate analyses, the final maps were generated according to the proximity, size and consistency regards. At the next step, they were modified using Group, Filter and Buffer models. Totally, about 63.17% of 26907 ha of the under investigation area for extensive recreational use were recognized as suitable (with the score of more than 100) which 17.25% of it have high potential to this use (score more than 200).

Extensive recreational Use Zone = (0.0264 ×[road_e]) + (0.0154 ×
[climt_e]+(0.0115×[elvt_e])+(0.2331×[slop_e])+
(0.0376×[aspc_e])+(0.0925×[vgty_e])+(0.0406 ×
[anbd_e])+(0.0611×[anhb])+(0.0624×[ecod_e])+
(0.0662[vghb_e]) + (0.1213 [ensp_e]) + (0.0405
[wtsu_e])+0.0212[grwt_e])+ (0.0114 [slty_e]) +
(0.0128 [sltx_e]) + (0.1420 [fhom_e])

IV. CONCLUSION

Land evaluation is a complicated process that depends on ecological and socioeconomic multiple criteria. In regard to plenty capability of GIS to solving, editing, analyzing and modeling, it is applied as a useful tool for planners in multiple criteria evaluations. Totally, 63.17% of 26907 ha from the area for implementation of extensive recreational use were recognized as suitable (score more than 100) that 464.46 ha equal 17.25% of that have high potential to this use (score more than 200). The spatial AHP method is a powerful decision support system for land evaluation studies. This research shows how fast and easy multiple criteria maps could be handled by AHP.

And also the result of this investigation confirmed that natural attractive and proximity of this area to Tehran city have been high potential for developing of recreational activities and ecotourism. Unfortunately, at present many aggressions is occurred in this area due to unsuitable management and mal-observation and expected opportunity in sustainable and wisely exploitation of this area treating. The Jajroud river pollution, the rapid changing of land uses, constructions and uncontrolled growth of population in area, are documents for these facts. It is suggested that with execution of comprehensive management plan of this protected area, culturing and public awareness especially is making powerful the local communities and also cessation and serious observation of land uses changing and constructions on this protected area have been done.

REFRENCES

[1] A.Ghoddousi, D.Ashayeri, E.Neinavaz, "An Avifaunal Survey of the Varjin Protected Area, Alborz Mountains, Tehran, Iran," Podoces 2(2),pp.97–105, 2007.

[2] A.Yalcin,"GIS-based landslide susceptibility mapping using analytical hierarchy process and bivariate statistics in Ardesen(Turkey):Comparisons of results and confirmations," CATENA, 72(1), pp.1-12, 2008.

[3] Bill. Wallace, "Becoming part of the solution: The engineer's guide to sustainable development. Washington," DC: American Council of Engineering Companies, 2005, ISBN 0910090378.

[4] J.Pezzey, M.Toman, "The Economics of Sustainability: A Review of Journal Articles," Resources for the Future DP 02-03: 1–36, 2002.

[5] J.Weiss, D.McLaren, "Victoria's pest plant prioritisation process," in H. S. Jacobs, J. Dodd and J.H. Moore (eds), Proceedings of the Thirteenth Australian Weeds Conference, Plant Protection Society of Western Australia, Perth, pp. 509-512, 2002.

[6] Mark. Jarzombek, "Sustainability - Architecture: between Fuzzy Systems and Wicked Problems," Blueprints 21/1, 2003, pp. 6–9.

[7] M.Kheirkhah, J.Ghoddusi, N.Zaredar, M.Soltani, S. Jafari, A.Ghadirpour,"Application of spatial analytical hierarchy process model in land use planning,"Journal of Food, Agriculture & Environment Vol.8(2), pp. 970-975, 2010.

[8] N.Mohajeri, Gh.Amin,"Railway station site selection using analytical hierarchy process and data envelopment analysis,"Computers& Industrial ngineering, 59(1), pp. 107-114, 2010.

[9] R.B.Thapa,Y.Murayama,"Land evaluation for peri-urban agriculture using analytical hierarchy process and geogragpic information system techniques: A case study of Hanoi," Land use pol. 25, 2007, pp. 225-239.

[10] S.Duleba, "An applicable method for elaborating agricultural logistics trends," J. Agr. Sci. Debrecen, 24:pp. 66-69, 2006.

[11] T.Cengiz, H.Celem, "Land use potential and suitability for areas of arable and garden farming, Meadow-pasture and recreation-tourism in Alpagut village," Bolu, Turkey,J, Appl. Sci. 6: 1641-1651, 2006.

[12] T.L. Saaty,"An exposition on the AHP in reply to the paper 'remarks on the analytic hierarchy process," Manag. Sci., 36:pp. 259–268, 1980.

[13] T.L. Saaty, "Decision Making for Leaders: The Analytic Hierarchy Process for Decisions in a Complex World," 3d ed. RWS Publications, Pittsburgh, PA, 1995.

[14] T.L. Saaty, "Multicriteria Decision Making: The Analytical Hierarchy Process," RWS Publications, Pittsburgh, PA, 1988.